HOST PLANT PREFERENCES OF CAGED POPULATIONS OF THE TOBACCO BUDWORM, CABBAGE LOOPER, AND SOYBEAN LOOPER.

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Host Plant Preferences of Caged Populations of the Tobacco Budworm, Cabbage Looper, and Soybean Looper, and Effect of Supplemental Releases of *Trichogramma pretiosum* and *Chrysopa carnea* on These Three Pests

Southern Region, Quincy, Fla. Location,
Agri. Res. Serv., USDA

and

Agricultural Research and Education Center,
IFAS, University of Florida, ~~Quincy, Fla.~~

Host Plant Preferences of Larval Populations of the Tobacco Hornworm, Cabbage Looper, and Soybean Looper, and Effect of Supplemental Releases of Trichogramma pretiosum and Chelonus [illegible]

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[illegible] [illegible], [illegible], [illegible],
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Southern Region, Quincy, Fla. Location,
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Agricultural Research and Education Center,
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University of Florida, Gainesville, Florida

Director, Agricultural Research and Education Center,
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I. INTRODUCTION

Knowledge of host preferences of pest species of insects could be useful in manipulating their numbers and diverting them from certain crops. For instance, trap crops might reduce numbers of a pest in a less desirable but marketable crop (or the marketable portion of this crop) to below economic levels, or at least alleviate heavy pressure from populations of a pest species.

Few host plant preference studies have been conducted on the tobacco budworm, Heliothis virescens (F.), the cabbage looper, Trichoplusia ni (Hubner), or the soybean looper, Pseudoplusia includens (Walker). However, Elsey and Rabb (1967) concluded from a study on cabbage loopers that collards were preferred over tobacco as sites for oviposition and that survival of the 1st-and 2nd-instar larvae of cabbage loopers was low in tobacco. Boling and Pitre (1971) found in field cage studies that cabbage loopers preferred cotton and collards for oviposition sites over broccoli, cauliflower, or cabbage.

The tobacco budworm is generally considered a major pest of cotton and tobacco; however, it has also been found on tomatoes, soybeans, and other crop hosts as well as numerous wild hosts (recently reviewed by Lincoln 1972). Like the tobacco budworm, the cabbage looper is commonly found on cotton, but it is also a major pest of crucifers. Tomatoes, beans, and tobacco, and numerous other crops are occasional hosts (Shorey et al. 1962, Tappan 1965). The soybean looper's common name suggests a preferred host and after collections from various crops in Louisiana and Alabama, Hensley et al. (1964) and Canerday and Arant (1966) did find most soybean loopers on soybeans. However, it has also been a pest of floricultural crops in southern California (Morshita et al. 1967), sweet corn in southern Florida (Janes and Greene 1970), and sunflowers in central Texas (Teetes et al. 1970), where few or no soybeans are available as host plants. Tobacco, collards, and garden beans have also been reported as hosts of the soybean looper (Crumb 1956, Eichlin and Cunningham 1969).

Teetes et al, (1970) suggests soybean loopers might also on occasion be pests of cotton and guar.

Supplemental releases of entomaphagous insects has been recognized as a potential means of controlling pest species for some time (Van den Bosch and Hagen 1966). Inundative releases of Chrysopa spp. and Trichogramma spp. have been tested for suppression of Heliothis spp. in cotton and results indicate both might be used to manage the pest to below economic levels in this crop (Lingren et al. 1968, Ridgway and Jones 1968, 1969, Kinzer et al. unpublished data, Lingren 1969, 1970, Lingren and Kim 1970, Ridgway et al. 1972.) In tomatoes, Oatman and Platner (1971) also used Trichogramma spp. on the tobacco budworm with positive results. And Trichogramma spp. have been used to increase parasitism of cabbage looper eggs on cabbage (Oatman et al. 1968) and tomatoes (Oatman and Platner 1971).

Supplemental releases of parasites and predators might be employed in several ways in a pest management system in conjunction with techniques utilizing knowledge of host preferences of pests present. Thus the objectives of the research reported here was 1) to investigate host plant preferences of the tobacco budworm, the cabbage looper, and the soybean looper and 2) to evaluate supplemental releases of Trichogramma pretiosum (Riley) and Chrysopa carnea (Stephens) for suppression of the three pests in various crops.

[illegible]

II. HOST PLANT PREFERENCES OF CAGED POPULATIONS OF TOBACCO BUDWORM, CABBAGE LOOPER, AND SOYBEAN LOOPER

PROCEDURES.--Tobacco Shade Experiment.--The first experiment on host preferences of the tobacco budworm, cabbage looper, and the soybean looper was conducted in a cigar-wrapper tobacco shade (232 X 192 X 9 ft) covered with loosely woven cotton cloth of 8 X 10 threads/in^2. The tobacco shade caged about one acre of land, except for several holes in the ceiling cloth which could not be patched. Crops in the shade (Fig. 1) were in five or ten 200-ft rows spaced 3-ft apart. Planting of Astro bush beans, Florida 20 tobacco, Hampton soybeans, Vates collards, Early Round Dutch cabbage, World Beater bell peppers, and Homestead tomatoes was begun on June 23 and completed by July 10 (Table 1).

Larval populations of the cabbage looper and the imported cabbageworm developed in the experimental plots prior to initiation of experiments in the shade in early August, making it necessary to apply a low residual insecticide, mevinphos, to prevent extensive insect damage to the crops. Later in August the cabbage was damaged by a disease (black rot) which rotted the developing heads. Also, the tomatoes became quite weedy with spiny amaranth, *Amaranthus spinosus* L.

Visual inspections during the experiment of amount of foliage and extent of insect, disease, and weed damage, indicated cabbage and tobacco were in the poorest condition. The foliage of the soybeans was in the best condition, followed by bell peppers, bush beans, collards, and tomatoes. Prior to the first release of moths in the shade (Aug. 9), numbers of plants per 10 ft of row were estimated at 30.9 for bush beans, 2.7 for tobacco, 25.2 for soybeans, 4.0 for collards, 4.8 for cabbage, 5.7 for bell peppers, and 2.8 for tomatoes.

Releases of laboratory-reared tobacco budworm and cabbage looper moths were made in the shade at a rate of 10 pair (female and male) of 1-, 2-, and 3-day-old moths every five days, beginning August 15 and ending August 25 (Table 2). Released and native cabbage looper moths provided high numbers of eggs in collards and cabbage; however, levels of tobacco budworm eggs were low in all crops. Thus, two additional releases of tobacco budworm moths were made (Aug. 19 and Sept. 1) for a total release of about 522 pair (Table 2). Two releases of 100 pair of 1-to 3-day-old soybean looper moths were made on August 31 and September 8. All moths were taken to the shade late in the evening in 1-gal ice cream containers and dispersed by walking diagonally across the crops and manually emptying the moths directly on the plants.

Numbers of eggs and larvae of Heliothis spp. and plusiinae (hereafter referred to as loopers) were estimated by examining all plants in ten 5- or 10-ft sections of row in all crops except tobacco. On September 1 and 13 only six 5-ft sections of row were examined. Sampling in tobacco consisted of 10-and/or 20-row ft sections (twice the row footage examined in other crops). The sampling areas were spread across a crop in a diagonal fashion and the direction of the diagonal was always reversed from that of the prior sampling date.

Most larvae found during whole plant inspections and some additional larvae found from random examinations of plants, were collected, placed on tobacco budworm diet (Berger, 1963), and brought into the laboratory for further examination. Species determinations on larvae of Heliothis spp. that reached the 3rd-instar were made. An additional determination was made on those larvae which reached the pupal or adult stage. Looper larvae were

identified only after they became adults.

Species determinations of eggs of Heliothis spp. and loopers were not attempted on but a few looper eggs. Thus, it did not compliment this research and is not reported.

Small Cage Experiment.--A second test was conducted in a 6 X 4 X 5-ft cage. In this test two plants of bush beans, tobacco, soybeans, collards, cabbage, bell peppers, tomatoes, and cockleburs, Zanthiun pennsylvanium Wallr, were transplanted at random in the cage. The tomatoes were in excellent condition throughout the test and possessed about twice as much foliage as any other hosts. Cabbage and bell peppers were in a poor condition relative to the other host plants.

A release of 30 pair of 3-to 5-day-old tobacco budworm moths was made on August 30, and another of 15 pair of 3-day-old tobacco budworm moths were made on September 9. Counts of eggs per plant were made 2 and 4 days after the first release and 1, 3, 4, 6, and 9 days after the second release.

Only one release of 15 pair of 2-to 4-day-old cabbage loopers was made on September 22. Egg counts were taken 1, 3, and 6 days after release.

Three releases of soybean loopers were made; on September 9 and 15, 10 pair of 1-to 3-day-old moths were released and on October 6, 20 pair of 4-day-old moths were released. Egg counts were made 1, 2, 3, and 5 days after the first release; 1, 2, 3, and 6 days after the second release; and 2 days after the third release.

RESULTS WITH THE TOBACCO BUDWORM.--In the tobacco shade test, results indicated tobacco, tomatoes, and peppers were the only hosts selected for oviposition by tobacco budworms and that tobacco was the preferred host (Tables 3 and 4). Ninety-eight percent of the tobacco budworm larvae collected were found on tobacco (Table 3b). Most larvae of Heliothis spp. on

tobacco were tobacco budworms (avg.of 82%), while most larvae on tomatoes and bell peppers and all of those on soybeans, bush beans, collards, and cabbage were found to be corn earworms. Tobacco, tomatoes, and soybeans were the only crops possessing substantial numbers of eggs and larvae of Heliothis spp.

Average numbers of eggs of Heliothis spp. in crops of the tobacco shade, were highest in tomatoes (45% of a total of averages) with tobacco ranking second (30% of a total of averages) (Table 4). On September 3, highest number of eggs (6) per 10 ft of row was found on tomatoes, following a tobacco budworm moth release of 350 pair on September 1. Despite the differences in numbers of eggs of Heliothis spp. found on tomatoes and tobacco, the numbers of larvae found in the two crops were about equal (Table 4). Perhaps tobacco budworms were not as successful in surviving on tomatoes. This may or may not have been due to nutritional characteristics of the tomatoes. It is likely that presence of parasites of Heliothis spp. in the tomatoes accounted for some of these differences.

In the second test (small 6 X 4 X 5-ft cage), results again indicated tomatoes and tobacco were the preferred hosts for oviposition by the tobacco budworm. Eighty-four percent of the eggs were found on tomato foliage and 11% on tobacco. Only 2% of the eggs found were on bush beans, and less than 1% on other hosts.

RESULTS WITH THE CABBAGE LOOPER AND SOYBEAN LOOPER.--In the tobacco shade test, results indicate collards was the preferred host of the cabbage looper (Tables 6 and 7). Collards and cabbage were definitely preferred over other available hosts. Fifty-five percent of total cabbage looper larvae collected were on collards, and 41% were on cabbage. (Table 6b). No other crop had over 3% of the cabbage looper larvae collected. The cabbage looper was the predominant looper species found in the shade, thus the majority of total

looper eggs and larvae were found in collards and cabbage (Table 7).

In the second test (small 6 X 4 X 5-ft cage), cabbage loopers also preferred collards and cabbage for oviposition to other available host plants(Table8). Forty percent of the eggs were found on collards and 30% on cabbage. Less than 5% of the eggs were found on the other hosts except for cockleburs which possessed 17%.

In the tobacco shade test, results indicated that soybeans were the preferred plant host of the soybean looper. Sixty-five percent of soybean looper larvae collected were found in soybeans (Table 6b). Soybean looper larvae were also found on collards, bush beans, cabbage, and tomatoes.

In the second test (small 6 X 4 X 5-ft cage), 52% of the soybean looper eggs were found on cockleburs, 31% on tomatoes, and 9% on soybeans (Table 8). The remaining 7% were found on bush beans, tobacco and peppers. In this test both tomatoes and cockleburs appeared to have more desirable foliage and this may have accounted for some of the differences in results in the shade and small cage.

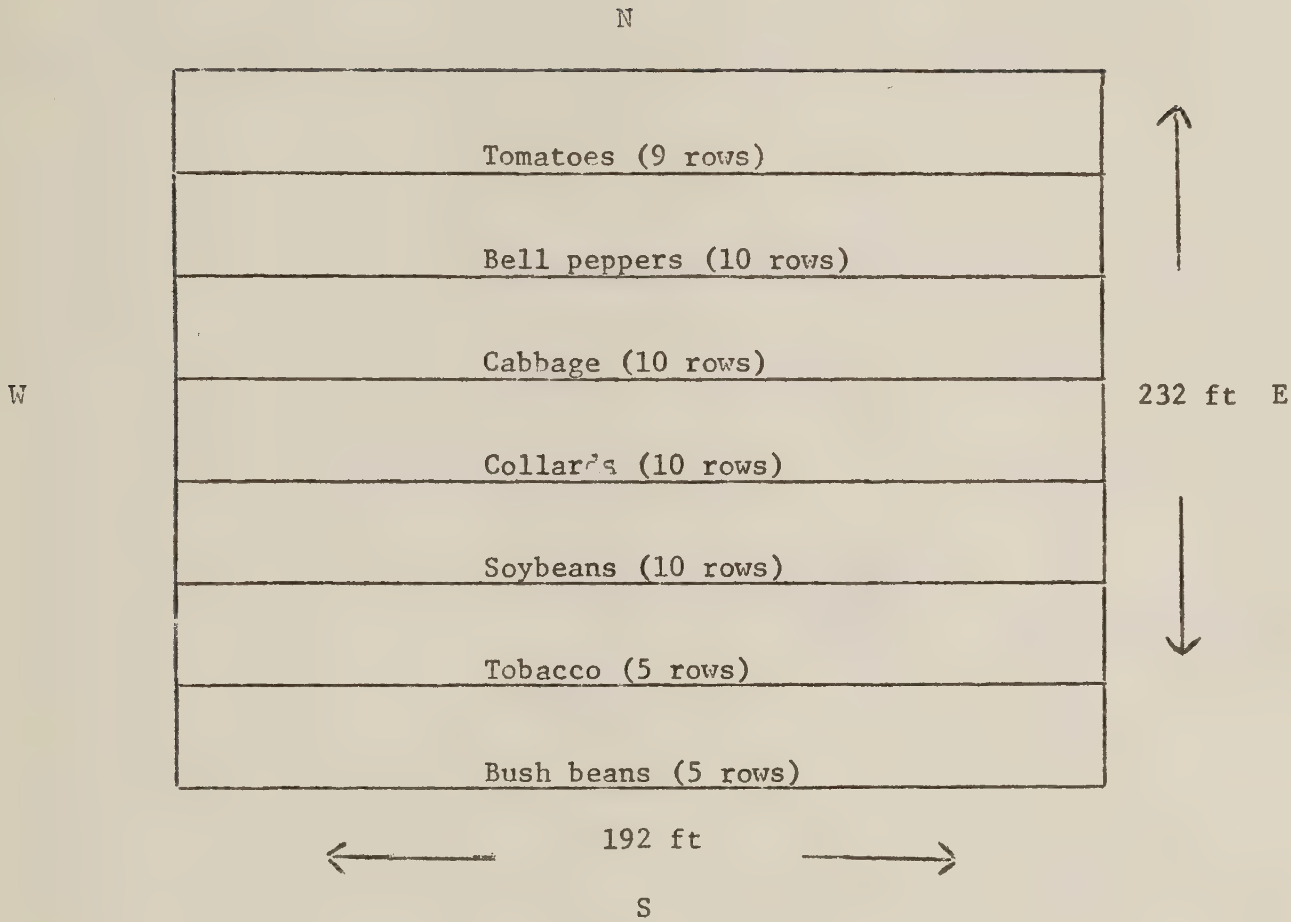

Figure 1. Diagram of crop positions in one-acre tobacco shade, Quincy, Fla., July-Sept., 1971.

Table 1. Calendar of crop culture in one-acre tobacco shade, Quincy, Fla., Jul.-Sept., 1971.

Date	Crop treatment	Rate/acre	Crop
June 23	Planting (Seedlings)	-	Pepper, tomatoes
July 1	Planting (Seeds)	-	Soybeans
July 6, 7	Planting (Seedlings)	-	Collards, cabbage
July 10	Planting (Seedlings)	-	Tobacco
Aug. 3	Fertilizer - 6-12-12 and 36-0-0	1000 lb and 50 lb	Pepper, tomatoes, collards, cabbage, tobacco, bush beans
	Fertilizer - 6-12-12	200 lb	Soybeans
	Cultivation	-	All crops
Aug. 5	Herbicide - DCPA	10 lb	Pepper, tomatoes, collards, cabbage
Aug. 6	Insecticide - Mevinphos	1.5 lb	All crops

Table 2.--Schedule of releases of lepidopterous insects in one-acre tobacco shade.

Release dates	No. released per acre[a] Tobacco budworm	Cabbage looper	Soybean looper
Aug. 15	30	30	-
Aug. 19	82	-	-
Aug. 20	30	30	-
Aug. 25	30	30	-
Aug. 31	-	-	100
Sept. 1	350	-	-
Sept. 8	-	-	100
Total	522	90	200

a/ Adult male and female pairs (1-3 days old).

Table 3a. Speciation of Heliothis larvae collected from crops grown in the one-acre tobacco shade.[a/][b/]

Date (Week of)	Bush beans	Tobacco	Soybeans	Collards	Cabbage	Bell peppers	Tomatoes
			% Tobacco budworm in crop				
Aug. 15	0	0	0	0	0	0	0
22	0	93	0	0	0	0	0
29	0	73	0	0	0	0	0
Sept. 5	0	97	0	0	0	33	0
12	0	95	0	0	0	0	7
19	0	82	0	0	0	0	3
Of total collected[c/]	0	92	0	0	0	33	3
			% Corn earworm in crop				
Aug. 15	0	0	100	0	0	0	0
22	0	7	100	0	0	0	100
29	0	17	100	0	0	0	0
Sept. 5	100	3	0	100	100	67	100
12	0	5	0	0	0	0	93
19	0	7	0	0	0	0	97
Of total collected[c/]	100	8	100	100	100	67	97

[a/] Species determinations were made following larvae collections from the field; source of species was wild and released moths.

[b/] Adult tobacco budworms were released in shade on 8/15, 20, and 25.

[c/] Percent of all Heliothis spp. larvae collected and identified from each crop that were tobacco budworm (top) or corn earworm (bottom).

Table 3b. Relative abundance of Heliothis species on each crop of the tobacco shade.[a]

Date (Week of)	Bush beans	Tobacco	Soybeans	Collards	Cabbage	Bell peppers	Tomatoes
				Tobacco budworm			
No. identified	0	123	0	0	0	1	2
Percent/crop[b]	0	97.6	0	0	0	0.8	1.6
				Corn Earworm			
No. identified	7	10	5	1	1	2	63
Percent/crop[b]	7.9	11.2	5.6	1.1	1.1	2.2	70.8

[a] Species determinations were made in the adult stage following larval collections from the field; sources of species was wild and released (tobacco budworm) moths.

[b] Percentage of all tobacco budworm or corn earworm larvae identified that were collected on designated crops.

Table 4.--Average numbers of eggs and larvae of <u>Heliothis</u> spp. per 10-row-ft per sample date on host plants grown in one-acre tobacco shade and percentage of eggs and larvae on each host.[a/][b/]

Date (Week of)	Bush beans	Tobacco	Soybeans	Collards	Cabbage	Bell peppers	Tomatoes
				Eggs			
Aug. 1	0.0	0.03	0.0	0.0	0.0	0.0	0.0
Aug. 8	0.31	0.0	0.05	0.0	0.05	0.0	0.0
Aug. 15	0.0	0.50	0.08	0.0	0.0	0.16	0.90
Aug. 22	0.15	0.35	0.45	0.0	0.0	0.0	0.50
Aug. 29	0.20	1.72	1.07	0.0	0.0	0.0	2.27
Sept. 5	0.02	0.96	0.05	0.0	0.0	0.02	0.37
Sept. 12	0.0	0.17	0.0	0.0	0.0	0.45	1.51
Sept. 19	0.0	0.05	0.0	0.0	0.0	0.0	0.10
Avg.	0.08	0.47	0.21	0.0	0.01	0.09	0.71
				% Heliothis spp. eggs/crop			
	5.1	29.9	13.4	0.0	0.6	5.7	45.2
				Larvae			
Aug. 1	0.0	0.18	0.0	0.0	0.0	0.0	0.03
Aug. 8	0.0	0.0	0.02	0.0	0.0	0.0	0.0
Aug. 15	0.02	0.0	0.02	0.0	0.0	0.0	0.35
Aug. 22	0.10	0.52	0.10	0.0	0.0	0.05	0.35
Aug. 29	0.0	0.40	0.03	0.0	0.07	0.0	0.13
Sept. 5	0.38	1.16	0.07	0.0	0.02	0.07	0.22
Sept. 12	0.0	2.40	0.10	0.15	0.0	0.0	2.65
Sept. 19	0.20	1.20	3.00	0.0	0.0	0.0	1.90
Avg.	0.09	0.73	0.42	0.02	0.01	0.02	0.70
				% Heliothis spp. larvae/crop			
	4.5	36.7	21.1	1.0	0.5	1.0	35.2

a/ Tobacco budworm adults were released 8/15, 20, 25 and 9/1.

b/ Samples were taken from 1 to 5 times per week and include progeny from released and wild moths.

Table 5. Oviposition on eight host plants by tobacco budworm following releases of adults in a 6 X 4 X 5-ft cage.[a]

	Bush beans	Tobacco	Soybeans	Collards	Cabbage	Bell peppers	Tomatoes	Cockle-bur
Avg. number eggs/ plant[b]	1.2	6.9	0.3	0.0	0.0	0.1	51.1	0.9
% Eggs on each type of plant	2.0	11.4	0.5	0.0	0.0	0.2	84.4	1.5

[a] A total of 45 pr of tobacco budworm moths were released on 8/30 and 9/9.

[b] Averages taken from 7 sampling dates following releases; progeny are from released moths only.

Table 6a--Speciation of looper larvae collected from crops grown in the one-acre tobacco shade.[a/][b/]

Date (Week of)	Bush beans	Tobacco	Soybeans	Collards	Cabbage	Bell peppers	Tomatoes
			% Cabbage looper in crop				
Aug. 15	0	0	100	97	100	0	0
Aug. 22	0	0	100	97	97	0	0
Aug. 29	100	0	50	100	100	0	0
Sept. 5	100	100	36	100	100	0	0
Sept. 12	50	0	0	100	100	0	0
Sept. 19	0	0	0	100	100	0	0
Of total collected[c/]	80	100	42	98	99	0	0
			% Soybean looper in crop				
Aug. 15	0	0	0	3	0	0	100
Aug. 22	0	0	0	3	3	0	0
Aug. 29	0	0	50	0	0	0	0
Sept. 5	0	0	64	0	0	0	0
Sept. 12	50	0	100	0	0	0	0
Sept. 19	0	0	0	0	0	0	0
of total collected[c/]	20	0	58	2	1	0	100

[a/] Species determinations were made in the adult stage following larval collections from the field; source of species was wild and released moths.

[b/] Adult cabbage loopers were released in shade on 8/15, 20 and 25; adult soybean loopers were released in shade on 8/31 and 9/8.

[c/] P-rcent of all looper larvae collected and identified from each crop that were cabbage looper (top) or soybean looper (bottom).

Table 6b.--Relative abundance of looper species on each crop of the tobacco shade.[a]

	Bush beans	Tobacco	Soybeans	Collards	Cabbage	Bell peppers	Tomatoes
			Cabbage Looper				
No. identified	4	2	8	195	145	0	0
Percent/crop[b]	1.1	0.6	2.3	55.1	41.2	0	0
			Soybean Looper				
No. identified	1	0	11	3	1	0	1
Percent/crop[b]	5.9	0.0	64.7	17.6	5.9	0.0	5.9

[a] Species determinations were made in the adult stage following larval collections from the field; source of species was wild and released moths.

[b] Percentage of all cabbage looper (or soybean looper) larvae identified that were collected or designated crops.

Table 7.--Average numbers of looper eggs and larvae per 10-row-ft per sample date on host plants grown in one-acre tobacco shade and percentage of eggs and larvae on each host.[a/][b/][c/]

Date (Week of)	Bush beans	Tobacco	Soybeans	Collards	Cabbage	Bell peppers	Tomatoes
				Eggs			
Aug. 1	0.17	0.0	0.0	1.42	0.11	0.06	0.0
Aug. 8	0.0	0.03	0.0	5.12	3.89	0.0	0.06
Aug. 15	0.08	0.14	1.22	17.86	14.20	0.84	0.90
Aug. 22	0.05	0.25	0.50	37.30	23.12	1.67	1.50
Aug. 29	0.27	0.03	1.83	19.20	10.20	0.10	1.33
Sept. 5	0.07	0.0	0.52	34.20	11.24	0.10	0.0
Sept. 12	0.0	0.17	0.10	18.65	8.05	1.90	0.18
Sept. 19	0.0	0.05	0.10	6.70	0.60	0.20	0.0
Avg.	0.08	0.08	0.54	17.56	8.92	0.61	0.50
				% looper eggs/crop			
	0.3	0.3	1.9	62.1	31.5	2.2	1.8
				Larvae			
Aug. 1	0.0	0.0	0.56	1.07	0.59	0.0	0.0
Aug. 8	0.0	0.0	0.15	2.92	1.15	0.0	0.0
Aug. 15	0.22	0.0	0.48	11.40	7.67	0.0	0.15
Aug. 22	0.0	0.0	0.35	11.36	6.15	0.30	0.10
Aug. 29	0.03	0.0	0.37	3.70	3.20	0.0	0.0
Sept. 5	0.42	0.07	1.20	15.98	8.40	0.02	0.02
Sept. 12	0.55	0.0	2.50	54.69	24.65	0.10	0.25
Sept. 19	0.60	0.0	0.0	8.20	0.70	0.20	0.0
Avg.	0.23	0.01	0.70	13.66	6.57	0.08	0.07
				% looper larvae/crop			
	1.1	0.0	3.3	64.1	30.8	0.4	0.3

[a/] Adult cabbage loopers were released 8/15, 20, and 25.

[b/] Adult soybean loopers were released 8/31 and 9/8.

[c/] Samples were taken from 1 to 5 times per week and include progeny from released and wild moths.

Table 8. Oviposition on eight host plants by cabbage looper and soybean looper following releases of adults in a 6 X 4 X 5-ft cage.

	Bush beans	Tobacco	Soybeans	Collards	Cabbage	Bell peppers	Tomatoes	Cocklebur
			Cabbage looper[a]					
Avg. number eggs/plant[c]	5.0	2.5	1.0	44.5	33.0	1.5	4.0	18.7
% Eggs found on each type of plant	4.5	2.3	0.9	40.4	29.9	1.4	3.3	17.0
			Soybean looper[b]					
Avg. number eggs/plant[d]	0.1	0.1	0.4	0.0	0.0	0.1	1.3	2.2
% Eggs found on each type of plant	2.7	2.7	9.3	0.0	0.0	2.7	30.7	52.0

[a] Fifteen pair of cabbage looper moths were released on 9/22. Progeny are from released moths only and all soybean loopers were removed from cage prior to the release of cabbage loopers.

[b] A total of [illegible]0 pair of soybean looper moths were released on 9/9, 9/15 and 10/6; progeny are from released moths only and all cabbage loopers were removed from cage prior to the last release of soybean loopers.

[c] Averages taken from 3 sampling dates after release.

[d] Averages taken from 9 sampling dates after releases.

III. EVALUATION OF SUPPLEMENTAL RELEASES OF *TRICHOGRAMMA PRETIOSUM* AND *CHRYSOPA CARNEA* FOR SUPPRESSION OF TOBACCO BUDWORM, CABBAGE LOOPER, AND SOYBEAN LOOPER ON SEVERAL CROPS

EXPERIMENTS WITH *TRICHOGRAMMA PRETIOSUM*

PROCEDURES.--In the first experiment (tobacco shade test) Trichogramma pretiosum Riley were evaluated in the seven crops of the tobacco shade for their potential of suppressing populations of the tobacco budworm, the cabbage looper, and the soybean looper. T. pretiosum were shipped from College Station in the larval stage in Sitotroga cerealella (Olivier) hosts glued to 4 heavy-weight black paper cards. After reaching Quincy, T. pretiosum were kept at about 27°C until the eighth day of their development. They were then placed in a dark room at a temperature of about 19° to 21°C in an effort to slow down development and attempt to manipulate the emergence of the T. pretiosum (Stinner and Ridgway 1971). Before storing in the cool environment, cards were cut into 60 equal portions and placed in 1/2-oz plastic jelly cups used for caging emerging T. pretiosum.

In the tobacco shade test T. pretiosum were released at an average rate of about 378,000 per acre (avg. of 354,000; 409,000; and 372,000) at three day intervals beginning August 17 and ending August 23. Releases for August 17 and 23 were made on odd numbered rows and on August 20 on even numbered rows, at eight positions within each row (about 22 ft apart). Sex ratio of the released T. pretiosum was probably about 1:6 (female/male).

T. pretiosum were manually emptied from the cups onto the foliage; then the cup and card was laid on a plant. In crops of sparse vegetation (e.g. tobacco and cabbage) numbers of released T. pretiosum were actually concentrated somewhat, since they were placed on the nearest foliage of the crop when the predetermined release areas were void of vegetation.

Cards possessing the developing T. pretiosum were sampled with a No. 7 cork borer (1/380 of a card) in two positions determined to be representative sampling areas (Stinner and Ridgway 1971). Emergence from

these samples was counted, averaged, and multiplied by 1520. Also numbers of T. pretiosum in 4 cups not used in field releases were counted, averaged, and multiplied by 240. Averages of the two estimates was used for the reported number of T. pretiosum released per acre (after rounding off to the nearest 1000's). The sex ratio for the T. pretiosum was estimated from other T. pretiosum shipped from College Station and emerging within one day of emergence of released T. pretiosum. Twelve samples of 100 individuals were sexed.

Numbers of eggs and larvae of Heliothis spp. and loopers in crops of the shade were estimated from regular examinations of whole plants as described in the procedures of Chapter II. Per acre estimates were made by multiplying the average number found per 10-ft section of row by 145[illegible] and rounding off to the nearest 10's.

During the whole plant inspections all eggs of Heliothis spp. and loopers, and some of the imported cabbageworm, Pieris rapae (L.), a hornworm (probably Manduca sexta (Johannson)), and the velvet bean caterpillar, Anticarsia gemmatalis Hubner, were collected and caged in cells formed with holes in cardboard covered with masking tape on one side and transparent tape on the other (Hoffman et al. 1970). They were brought into the laboratory and allowed to develop at about 27°F. Sex ratios and number of Trichogramma spp. emerging per egg were estimated from 40 Heliothis spp. eggs and 100 looper eggs.

In the second experiment (soybean field test) about 1.3 acres of soybeans were treated with releases of T. pretiosum on August 23, 26, 30, and September 11. Per acre release numbers were about 612,000; [illegible]; 650,000; and 588,000. Sex ratio of released T. pretiosum was

[illegible] samples was counted, averaged, and multiplied by 1520. [illegible]

numbers of T. *pretiosum* in 4 cups not used in [illegible]

[illegible] counted, averaged, and multiplied by 240. Averages of the two estimates

rounding off to the nearest 1000's). The sex ratio for the *pretiosum*

was estimated from other T. *pretiosum* shipped from [illegible]

and emerging within one day of emergence of released T. *pretiosum*.

Twelve samples of 100 individuals were sexed.

[illegible] and larvae of *Heliothis* spp. and loopers [illegible] crops

of the shade were estimated from regular examination of whole plants

as described in the procedures of Chapter [illegible] estimates

were made by multiplying the average number [illegible] per 10-ft section of

row by 145 and [illegible] off to the nearest 10's.

During the whole plant inspection [illegible] *Heliothis* spp. [illegible]

loopers, [illegible] of the imported cabbageworm, [illegible]

hornworm (probably *Manduca sexta* (Johannson)), and the velvet bean cater-

pillar, *Anticarsia gemmatalis* Hubner, were collected and caged [illegible] cells

formed with holes in cardboard covered with masking tape on one side

[illegible] tape on the other (Hoffman et al. 1970). They were

brought into the laboratory and allowed to develop at about 27°F

[illegible] and number of *Trichogramma* spp. emerging per egg were estimated

[illegible] *Heliothis* [illegible] eggs [illegible] 100 looper eggs.

. Per acre release numbers were about 112,000;

8,000. Sex ratio of released T. *pretiosum* was

about 1:7 (female/male) (9 samples of 100 individuals were used in obtaining the sex ratio.) Parasitism was monitored by collection of eggs deposited by laboratory-released moths caged on sections of row in the soybean field and by collection of eggs oviposited by wild moths. In the test, six to ten mated female soybean looper moths were released in four 2 X 2 X 4-ft cages (covered with screen wire (20 X 20 mesh) or Saran® screen (18 X 14 mesh)) placed about 16 rows apart and diagonally across the field on August 18, 27, 31, and September 3. On September 9 only three of the cages had soybean loopers introduced and on September 3 and 8, ten mated female velvet bean caterpillar moths were released in one of the 4 cages.

Whole plant inspections for eggs in the area covered by cages were made on August 23, 30, and September 2, 6, 7, and 13. After September 13 eggs were collected at random in the field by checking 10-ft sections of row.

RESULTS ON HELIOTHIS SPP.--Parasitism of eggs of *Heliothis* spp. collected from soybeans and tomatoes was 100% on several occasions and estimates of average numbers of larvae per acre were lower than estimated numbers of eggs. (Table 9). However, tobacco was the only crop in which substantial numbers of tobacco budworm larvae were found. And although numbers of eggs of *Heliothis* spp. in tobacco were higher than in soybeans or tomatoes, egg parasitism was only recorded on the initial date of *T. pretiosum* releases, when two eggs were found parasitized.

A few eggs of *Heliothis* spp. were found in bush beans, collards, and peppers. However, the numbers were too low to monitor parasitism by *Trichogramma* spp. with any accuracy. (Table 9 and 10).

Egg parasitism of Heliothis spp. eggs collected in all crops of the tobacco shade increased from about 5% prior to supplemental releases of T. pretiosum to about 43% during the release period. (Table 10). Parasitism remained high in tomatoes even after releases were terminated. (Apparently the host density remained high enough and this host-habitat was suitable for the parasite to maintain a generation cycle). An average of 3.6 Trichogramma spp. with an average sex ratio of 1:8 (female/male) emerged from eggs of Heliothis spp. collected from crops of the shade.

In the soybean field test only 3 eggs of Heliothis spp. were collected. One of these was parasitized by Trichogramma spp.

RESULTS ON LOOPERS.--In the tobacco shade test, following releases of T. pretiosum, parasitism of looper eggs reached levels calculated at 67, 86, 100, 54, and 73% in soybeans, peppers, tomatoes, collards, and cabbage, respectively; and suppression of hatch of looper larvae was evident. (Table 11). However in collards and cabbage, where looper egg numbers were estimated as high as 102,000 per acre, suppression of larval numbers did not approach an economic level. Numbers of loopers in bush beans and tobacco did not reach levels high enough to evaluate suppression levels by Trichogramma spp.

Egg parasitism of all looper eggs collected in all crops of the shade increased from about 2% prior to supplemental releases of T. pretiosum to about 54% during the release period (Table 12). Parasitism decreased after releases of T. pretiosum were terminated; however, it remained high in tomatoes. An average of 2.3 Trichogramma spp. with and average sex ratio of 2.2 (female/male) emerged from looper eggs collected in the shade.

<u>SUPPRESSION OF CABBAGE LOOPERS</u>.--In collards, numbers of cabbage looper larvae were kept well below numbers of eggs oviposited, until mid-September (Table 11). Highest numbers of eggs were found on August 17, 27, and September 6, when they reached levels of about 41,000; 63,000; and 60,000 per acre, respectively. Peak larval numbers following these high numbers of eggs were estimated at about 33,000 on August 20; 26,000 on September 6; and 102,000 on September 13. About 50% of the larvae found on September 13 were in the 1st- or 2nd-instar. From this information egg mortality for the first two egg peaks may be estimated at about 22% and 59%. <u>Trichogramma</u> spp. parasitism was estimated to be about 45% and 35% during these periods. When only 1st- and 2nd-instar larvae were used in calculating egg mortality during the third egg peak, mortality was estimated to be about 15%.[1/] <u>Trichogramma</u> spp. parasitism was estimated at about 18% during this period (estimate is from Sept. 7).

Numbers of cabbage looper eggs and larvae found in cabbage were similar to those in collards. (Table 11). Highest numbers of eggs found were on August 19, 25, and September 6, when estimates were 35,000; 39,000; and 30,000 per acre. Peak larval numbers following these high numbers of eggs were estimated at about 14,000 per acre on August 25; 16,000 per acre on September 6; and 48,000 per acre on September 13. About [illegible]4% of the larvae found on September 13 were in the 1st- 2nd-instar. Thus from this information egg mortality for the

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[1/] Larvae were not accurately sized in the earlier counts, thus calculations were based on total larvae.

first two egg peaks may be estimated at about 60% and 59%. Trichogramma spp. parasitism was estimated at about 63% and 55%. When only 1st- and 2nd-instar larvae were used in calculating egg mortality of the third egg peak, estimates of mortality were 13%.[2/] No eggs were collected on September 6 and Trichogramma spp. parasitism was estimated at 41% on September 7. However, parasitism from August 27 through September 3 averaged only 12%.[3/]

In bell peppers, although egg numbers reached levels of 6,000 and 4,000 per acre, estimates of numbers of larvae were never over 1,000 per acre and numbers were probably well below the economic threshold. Trichogramma spp. parasitism was quite high immediately following releases; however, when the two major peaks of eggs occurred (Aug. 27 and Sept. 15) estimations of parasitism were 25% and 0%, respectively. Thus apparent suppression of larval numbers was probably due in part to other factors.

In tomatoes, like peppers, cabbage looper egg numbers reached fairly high levels but numbers of larvae were never estimated at over 1000 per acre. Estimates of Trichogramma spp. parasitism was high, often reaching 100%.

[2/] ibid.

[3/] One looper egg found in cabbage was parasitized by Telenomus sp. However, no others were found from eggs collected in cabbage or other crops. Recent studies on mortality factors of Heliothis spp. and loopers in a cropping system near Quincy, Florida (Martin et al. 1973 a, b) indicate Telenomus spp. probably do not play an important role in suppressing numbers of these pests in this region.

In soybeans, there was one peak of cabbage looper eggs which rose above 4,000 per acre (on 8-18). Apparently numbers of larvae were suppressed to below 2,000 per acre by Trichogramma spp. parasitism of about 57%.

In the second test in the soybean field no cabbage looper eggs were found.

SUPPRESSION OF SOYBEAN LOOPERS.--Only in soybeans were soybean looper numbers high enough to test suppression by Trichogramma spp.. In the tobacco shade test however, numbers of soybean looper eggs increased in the soybeans when Trichogramma spp. numbers were probably low; thus an egg peak of about 6,000 per acre on September 3 was followed by larval numbers estimated at over 7,000 per acre (Table 11). Trichogramma spp. parasitism of eggs collected on September 3 was only 10%.

In the soybean field test, results showed parasitism of soybean looper eggs did occur and was probably more effective immediately following the releases of T. pretiosum (Table 13). However insufficient collections of eggs made estimates of levels of parasitism impractical.

EGG PARASITISM OF OTHER SPECIES COLLECTED.--Competition as alternate hosts for Trichogramma spp. by other pests in the tobacco shade was probably slight. Although many imported cabbageworm eggs were collected during periods of peak parasitism of Heliothis spp. and looper eggs, few of the eggs were parasitized (Table 14). Collected hornworm and velvet bean caterpillar eggs in the tobacco shade also yielded few parasitized eggs; however all were collected at least 4 days after termination of T. pretiosum releases.

In the soybean field test, parasitism of velvet bean caterpillar eggs averaged 36%. Twenty-eight of the eggs were collected on September 13, two days following a release of T. pretiosum, and 68% of the eggs were parasitized.

Table 9. Numbers of eggs and larvae of *Heliothis* spp. found on crops in one-acre tobacco shade and parasitism of eggs of *Heliothis* spp. by *Trichogramma* spp..

Date	Tobacco			Soybeans			Tomatoes		
	No. eggs/ acre	No. larvae/ acre	% eggs parasitized	No. eggs/ acre	No. larvae/ acre	% eggs parasitized	No. eggs/ acre	No. larvae/ acre	% eggs parasitized
Aug. 4	40	260	-	0	0	-	0	40	-
11	0	0	-	70	40	-	0	0	-
12	-	-	0	-	-	-	-	-	0
13	-	-	-	-	-	-	-	-	-
16	1820	-	0	0	-	0	0	1890	17
17[a]	1090	0	15	290	0	33	1310	140	73
18	0	0	0	0	140	-	580	0	50
19	220	0	0	0	0	82	2620	0	100
20[a]	290	0	-	290	0	100	2330	0	-
23[a]	140	0	0	0	0	-	290	290	100
24	140	580	0	0	290	100	580	0	0
25	730	1890	0	870	0	100	290	1160	100
27	1020	580	0	1740	290	50	1740	580	30
30	0	290	-	0	0	0	1160	290	100
Sept. 1	0	580	0	0	0	0	0	0	0
3	7490	870	0	4650	140	10	8720	290	66
6	5300	730	-	290	0	-	0	290	-
7	70	870	0	0	0	-	730	580	50
9	140	3790	0	0	140	-	440	290	69
10	70	1240	-	0	290	-	1020	140	80
13	510	1450	-	0	0	-	0	3920	-
15	0	2760	-	0	290	-	6400	3780	92
22	70	1750	0	0	4360	-	140	2760	100
Avg.[b]	960	960	1	450	330	68	1580	800	67

(Cont.)

Table 9. (Cont.)

Date	Bush beans			Bell peppers		
	No. eggs/ acre	No. larvae/ acre	% eggs parasitized	No. eggs/ acre	No. larvae/ acre	% eggs parasitized
Aug. 4	0	0	-	0	0	-
11	450	0	-	0	0	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
16	0	-	-	-	0	0
17[a]	0	0	-	0	0	-
18	0	140	-	0	0	-
19	0	0	-	190	0	50
20[a]	0	0	-	870	0	-
23[a]	0	290	-	0	0	-
24	290	0	0	0	0	-
25	0	0	-	0	0	-
27	580	290	-	0	290	-
30	0	0	-	0	0	-
Sept. 1	0	0	-	0	0	-
3	870	0	0	0	0	-
6	0	0	-	0	0	-
7	0	730	-	0	0	-
9	0	1170	-	0	440	-
10	140	290	0	140	0	0
13	0	0	-	1020	0	0
15	0	0	-	290	0	-
22	0	290	-	0	0	-
Avg.[b]	100	180	0	140	40	17

[a] T. pretiosum were released on Aug. 17, 20, 23 at rates averaging 378,000 per acre. Counts and collections of eggs on these dates were taken after releases were made.

[b] Average of daily estimates following the initial releases of T. pretiosum (Aug. 17).

Table 10. Parasitism and hatch of those eggs of Heliothis spp. 1) collected prior to T. pretiosum releases 2) collected immediately after the initial releases of T. pretiosum until 2 days after the final release, and 3) collected 4 days after the final release until sampling was terminated.

	No. eggs collected	% parasitism[a]	% hatch[a]
	Pre-release (Aug. 4-16)		
Tobacco	21	0.0	81.0
Soybeans	4	0.0	75.0
Tomatoes	14	14.3	85.7
Bush beans	0	-	-
Peppers	1	0.0	100.0
Collards	1	0.0	100.0
Total[b]	41	4.9	82.9
	Initial release - 2 days after final release (Aug. 17-25)		
Tobacco	30	6.7	76.7
Soybeans	20	70.0	20.0
Tomatoes	25	68.0	16.0
Bush beans	2	0.0	100.0
Peppers	2	50.0	0.0
Total[b]	79	43.0	41.8
	4 Days after final release to Termination of sampling (Aug. 27-Sept.22)		
Tobacco	37	0.0	78.4
Soybeans	23	13.0	65.2
Tomatoes	142	63.4	33.1
Bush beans	9	0.0	33.3
Peppers	2	0.0	100.0
Total[b]	213	43.7	45.1

[a] The remainder of eggs either collapsed, or were crushed when collected. Soybeans and bush beans are probably the only crops with a high percentage of eggs that were crushed when collected.

[b] Percent parasitism and hatch of all eggs collected.

Table 11. Numbers of looper eggs and larvae found on crops of the tobacco shade and parasitism of eggs by Trichogramma spp..[a]

Date	Collards No. eggs/ acre	Collards No. larvae/ acre	Collards % eggs parasitized	Cabbage No. eggs/ acre	Cabbage No. larvae/ acre	Cabbage % eggs parasitized	Bell peppers No. eggs/ acre	Bell peppers No. larvae acre	Bell peppers % eggs parasitized
Aug. 4	2070	1550	0	160	860	0	90	0	-
11	7450	4250	-	5660	1680	-	0	0	-
12	-	-	1	-	-	0	-	0	-
13	-	-	4	-	-	5	-	-	-
16	8580	-	2	6250	0	0	290	-	50
17[b]	41150	16870	45	26320	10180	60	2130	0	33
18	22680	7850	70	18900	15270	69	440	0	67
19	31840	9020	54	35190	8430	63	1450	0	86
20[b]	25590	32570	54	16580	10760	73	1740	0	75
23[b]	4450	21290	32	3230	12210	61	1740	870	50
24	57290	12500	53	34020	6110	42	870	0	50
25	51760	22970	53	39260	14250	55	580	290	0
27	63390	9310	35	28900	3200	12	6540	580	24
30	16280	5820	35	3050	4940	7	290	0	0
Sept.1	19970	7270	17	14250	5820	15	0	0	-
3	47690	3050	9	27190	3200	16	140	0	0
6	60050	26320	-	29660	16570	-	0	0	-
7	57870	20360	18	16280	14540	41	530	0	0
9	43180	18900	20	11780	6790	38	0	140	-
10	37800	27340	17	7270	11260	8	0	0	-
13	14980	102220	36	4800	48420	30	1450	0	50
15	39260	56820	26	18610	32360	39	4070	290	0
22	9740	11920	12	870	1020	40	290	290	0
Avg.[c]	35820	22910	34	18680	12010	39	1240	140	31

(con't)

Table 11. (Cont.)

Date	Tomatoes			Soybeans			Bush beans			Tobacco		
	No.eggs/	No.larvae/	% eggs	No.eggs/	No.larvae/	% eggs	No.eggs/	No.larvae/	% eggs	No.eggs/	No.larvae/	%eggs
Aug. 4	0	0	-	0	810	-	250	0	-	0	0	-
11	80	0	-	0	200	-	0	0	-	40	0	-
12	-	-	-	-	-	-	-	-	-	-	-	0
13	-	-	-	-	-	-	-	-	-	-	-	-
16	290	-	0	0	-	0	440	-	0	290	-	0
17[b]	580	140	100	1430	140	31	140	140	0	0	0	-
18	1890	730	92	4220	2620	57	0	290	-	140	0	-
19	3150	0	61	1310	0	67	0	0	-	580	0	20
20[b]	580	0	-	580	0	0	0	870	-	0	0	-
23[b]	4940	290	62	870	580	0	0	0	-	440	0	0
24	870	0	-	580	1450	0	290	0	-	290	0	0
25	1160	290	100	580	0	67	0	0	-	730	0	0
27	1740	0	-	870	0	43	0	0	0	0	0	-
30	290	0	100	0	580	-	0	0	-	0	0	-
Sept.1	290	0	-	2040	290	14	580	0	0	0	0	-
3	5230	0	20	5960	730	10	580	140	0	140	0	-
6	0	0	-	290	1320	-	440	1020	-	0	0	-
7	0	0	-	0	1450	-	0	140	-	0	0	-
9	0	140	-	440	440	0	0	870	-	0	0	-
10	0	0	-	330	3780	9	0	440	-	0	440	0
13	0	440	-	0	7270	-	0	1020	-	510	0	0
15	580	290	33	290	0	0	0	580	-	0	0	0
22	0	0	-	140	0	0	0	870	-	70	0	0
Avg.[c]	1740	130	72	1220	1147	21	110	350	0	157	20	2

a/Underlined numbers are for clarification when they were mentioned specifically in the test.

b/*T. pretiosum* were released on Aug. 17, 20, 23 at rates averaging 378,000 per acre. Counts and collections of eggs on these dates were taken after releases were made.

c/Average of daily estimates following the initial releases of *T. pretiosum* (Aug. 17).

Table 12. Parasitism and hatch of those looper eggs 1) collected prior to T. pretiosum releases, 2) collected immediately after the initial release of T. pretiosum until 2 days after the last release, and 3) collected 4 days after the final release until sampling was terminated.

	No. eggs collected	% parasitism	% hatch
	Pre-release (Aug. 4-16)		
Collards	324	1.8	94.4
Cabbage	196	1.0	90.3
Bell peppers	2	50.0	50.0
Tomatoes	2	0.0	100.0
Soybeans	1	0.0	100.0
Bush beans	4	0.0	75.0
Tobacco	14	0.0	100.0
Total[a]	543	1.6	92.8
	Initial release - 2 days after final release (Aug. 17-25)		
Collards	1133	50.9	44.9
Cabbage	931	57.5	36.7
Bell peppers	39	56.4	23.1
Tomatoes	62	67.7	14.5
Soybeans	59	49.2	39.0
Bush beans	1	0.0	0.0
Tobacco	9	11.1	77.7
Total[a]	2234	54.0	40.2
	4 days after final release - Termination of sampling (Aug. 27 - Sept. 22)		
Collards	1630	20.1	75.8
Cabbage	549	26.2	69.0
Bell peppers	31	22.6	45.2
Tomatoes	15	53.3	40.0
Soybeans	85[b]	8.2	75.3
Bush beans	5	0.0	80.0
Tobacco	3	0.0	100.0
Total[a]	2303	21.2	73.6

[a] Percent parasitism and hatch of all eggs collected.

[b] Most of these were probably soybean looper eggs.

[c] Some of these may have been damaged when collected; however, soybeans and bush beans were probably the only crops with a high percentage of damaged eggs.

Table 13. Parasitism by Trichogramma spp.of soybean looper eggs collected from a soybean field.[a/]

Date	No. eggs collected[b/]	% parasitized
Aug. 24	140	47.8
30	84	23.0
Sept. 2	12	8.3
6	73	0.0
7	32	9.4
13	1	0.0
14	3	0.0
17	2	50.0
20	14	14.3
24	6	0.0

[a/] T. pretiosum were released on Aug. 23, 26, 30 and Sept. 11.

[b/] From Aug. 24, 30, Sept. 2, 6, 7, 13, and 20, eggs were those oviposited by caged moths; however, on Sept. 14, 17, and 24, eggs were collected by whole plant inspection on uncaged plants.

Table 14. Parasitism of eggs of other lepidopterous hosts in crops grown in one-acre tobacco shade (TS) and in a soybean field (SBF) following releases of T. pretiosum.

Host	Total no. eggs	% parasitized	% hatched	% collapsed[e]
Imported cabbage worm (TS)[a]	1,381	0.4	52.1	47.5
Hornworm (TS)[b]	14	7.1	92.9	0.0
Velvet bean caterpillar (TS)[c]	11	9.1	81.9	0.0
(SBF)[d]	50	36.0	62.0	2.0

[a] Collected Aug. 5 - Sept. 1 on collards and cabbage in the tobacco shade.

[b] Collected Aug. 27 - Sept. 15 on tobacco, bell peppers, and tomatoes in the tobacco shade.

[c] Collected Sept. 10, 15, and 22 on soybeans in the tobacco shade.

[d] Collected Aug. 24, Sept. 6, 13, and 14 in the soybean field.

[e] Eggs crushed in this test were labeled immediately so they would not be confused with collapsed eggs.

EXPERIMENTS WITH *CHRYSOPA CARNEA*

PROCEDURES.--Chrysopa carnea Stephens were also evaluated for use in suppressing numbers of the tobacco budworm, the cabbage looper, and the soybean looper. C. carnea were shipped from College Station (in three 3-gal cylindrical cartons) as eggs mixed with sawdust and previously frozen eggs of S. cerealella (food source). On arrival at Quincy, C. carnea were allowed to develop at about 27°C.

In the major test with C. carnea on crops of the tobacco shade, releases of larvae of C. carnea were made on one-half of each crop (2½ rows in bush beans and tobacco and 5 rows in the rest of the crops). Three releases were made on all crops except soybeans and collards, on which four releases were made. The first two releases, one of about 240,000 larvae per acre and the other of about 210,000 larvae per acre, were made on August 20 and 27. The third release of about 130,000 larvae per acre, was made on two separate days; one-half of the C. carnea-containing-sawdust was spread over the release plots on September 4 and one-half was dispensed on September 5. On September 16 the release plots in soybeans and collards were treated at a rate of 50,000 per acre. Larvae of C. carnea released on August 20 and 27 were about 2 days old; those released on September 4 and 5 were 3-5 days old; and those on September 16 were about 7 days old. Estimates of number of C. carnea released were made by counting two 0.5-pt aliquots from each 3-gal carton.

Sawdust containing the C. carnea was distributed from a gal carton evenly on to the plant foliage late in the afternoon. Three-tenths of a gallon was dispensed on each 200-ft row.

Numbers of eggs and larvae per acre of Heliothis spp. and loopers in release and control plots of crops of the shade were estimated as described in the procedures of Chapter III. Chrysopa spp. were also searched for during whole plant inspections. Also on August 28, numbers of Chrysopa spp. larvae in release plots were estimated by taking two 10-ft sections in the first two rows of each crop and counting only Chrysopa spp. larvae.

Chrysopa spp. were also counted in samples taken by a vacuum sampler similar to that described by Detrick (1961). One hundred foot of row in the C. carnea release area and in the non-release area of each crop (200 ft per crop) was sampled with a D-vac machine having a $1/3ft^2$ sampling head. The samples were stored in a freezer and when time permitted Chrysopa spp. were searched for and counted under magnification. These Chrysopa spp. were collected and sent to a taxonomist for identification.

Foliage damage and fruit damage in C. carnea release and control plots was evaluated. Foliage was rated using a system similar to that used by Greene et al. (1969). The rating system was used as a scale ranging from 1 to 6 as follows: 1) no apparent insect feeding, 2) 0 - 1% leaf area eaten, 3) 2 - 5% leaf area eaten, 4) 6 - 10% leaf area eaten, 5) 11- 30% leaf area eaten, and 6) over 30% of the leaf area eaten.

Number of fruit in C. carnea release and control plots and fruit damage by larvae of Heliothis spp., was estimated for all crops except tobacco, collards, and cabbage. Estimates after harvest were made on bell peppers (Aug. 31 and Step. 16), bush beans (Sept. 8), and tomatoes (Sept. 7 and 22). Other estimates were made in 5 to 10 ft sections of row in the C. carnea release and control plots.

Several additional tests were made on C. carnea since releases in the tobacco shade did not appear to be effective in suppressing numbers of the lepidopterous pests and since recovery of released C. carnea through whole plant inspections or D-vac sampling was very low or nil. Larvae were held in the sawdust until use in these tests and may have been in a weakened condition.

plots of ... of the ... estimates ... by ...

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In the first of these tests, an attempt was made to measure feeding of C. carnea on soybean looper eggs and to find larvae of C. carnea 24 hr after release in the field. About two hundred 4 to 6-day-old larvae were released in 3-ft sections of row of soybeans (uncaged in a field near the station) containing 50 soybean looper eggs which had been cemented to the lower leaf surface with egg albumin. Control plots were also set up and the test was replicated four times. Whole plant inspections for eggs (which had been tagged by strings on leaves where they were placed) and C. carnea were made after 24 hr.

In a second test, attempts were made to recover C. carnea in soybeans following releases. About 2544 seven-day-old C. carnea were released in a 6 X 6 X 12ft cage containing near-defoliated soybeans and numerous soybean looper moths. Whole plant inspections for larvae of C. carnea were made after 24 hr.

In a third test, survival and growth of larvae of C. carnea on crops of the one-acre tobacco shade was observed. Larvae of C. carnea were caged on a portion of a plant in each crop in 1-gal ice cream cartons. One end of the carton was pressed and taped tightly to a flat cardboard surface that has been fastened around the plant stem securely. Cotton cloth was stretched over the other end. Six larvae of C. carnea were released per carton and this was replicated three times for each crop. Fifty to 200 cabbage looper eggs were offered as a food source by being cemented to leaves that the larvae of C. carnea were placed on. After the 24 hr check, the 1-gal cartons were taken off, however; the cardboard "collar" remained. Any larvae of C. carnea found on the sides of the carton were placed back on the plants near the cabbage looper eggs. C. carnea were counted again at 48 and 72 hr.

The fourth test was conducted in the laboratory to determine capability of the shipped C. carnea for consuming eggs and larvae of budworms, cabbage loopers, and soybean loopers. Eggs of the tobacco budworm, (20) the cabbage looper (20), and the soybean looper (67-109) were offered to individual larvae of C. carnea in 1-.r vials. Ten 1st-instar-larvae of the tobacco budworm and the cabbage looper

these pages, an attempt was made to [illegible]

[illegible] eggs [illegible] to find larvae of *C. carnea*

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of row of soybeans (uncaged in a trial [illegible]

looper eggs which had been [illegible]

[illegible] of

[illegible] soybean [illegible] larvae [illegible] after release

[illegible] and *C. carnea* were [illegible] larvae [illegible]

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The fourth test was conducted in [illegible]

[illegible] for consuming eggs and larvae of [illegible]

[illegible] loopers [illegible] eggs [illegible] the tobacco budworm, [illegible] the cabbage looper [illegible]

[illegible] were offered to individual larvae of *C. carnea*

[illegible] larvae of [illegible] tobacco budworm and the cabbage looper

were presented to individual larvae of _C. carnea_ in ½-oz plastic jelly cups containing looper larval diet similar to that described by Henneberry and Kishaba 1966. Consumption of eggs and larvae and mortality of the larvae of _C. carnea_ was recorded.

RESULTS.--_Tests for Suppression of Heliothis spp. and Loopers in Tobacco Shade._--Average numbers of eggs and larvae of _Heliothis_ spp. per acre in soybeans, bell peppers, and tomatoes were higher in _C. carnea_ release plots than in control plots (Table 15). Thus, results indicate no reduction in numbers of eggs and larvae of _Heliothis_ spp. from releases of larvae of _C. carnea_ in these crops.

However, in bush beans and tobacco both eggs and larvae of _Heliothis_ spp. were lower in release plots than in control plots (Table 15). Differences in numbers of larvae found in release and control plots of these crops were slight and did not occur during each week of sampling. But differences in egg numbers occurred during each week eggs were found, except one in tobacco.

Results from counts of looper larvae in tobacco, soybeans, bell peppers, and tomatoes indicate there was no reduction by _C. carnea_ (Table 16). However, in bush beans, collards, and cabbage, average numbers of looper larvae estimated per acre were lower in _C. carnea_ release plots than in control plots.

In bush beans, tobacco, cabbage, bell peppers, and tomatoes, the average of estimated numbers of looper eggs was slightly lower in release plots than in control plots. Numbers of looper eggs were higher in release plots than control plots in soybeans and collards even though these crops had received an extra application of _C. carnea_.

Despite some differences in numbers of _Heliothis_ spp. and loopers found in _C. carnea_ release and control plots of crops of the shade, few _Chrysopa_ spp. larvae were found from either whole plant inspection or D-vac samples (Table 17). Although numerous cabbage loopers, and imported cabbage worms were available as a food source on collards and cabbage following _C. carnea_ releases, _Chrysopa_ spp. were found on only 3 of 16 sampling dates in either whole plant inspection or D-vac

samples.

Highest number of Chrysopa spp. found on a crop was on August 28 in bush beans, but that was only ca. 15 hr after releases were made, and when the number found was converted to a per acre estimate it was only about 11% of the release estimate. All estimates of Chrysopa found per acre, other than those from August 28, were less than 2% of the release estimate.

Differences in damage to C. carnea release and control plots of crop of the shade were slight or nil. Results from foliage rating (Table 18) indicated a lower rating of damage only in tobacco and cabbage. In none of the crops checked was average percent of damage to fruit by Heliothis spp. lower in C. carnea release plots than in controls (Table 19). Average numbers of fruit estimated in release plots was higher than in controls in bush beans, soybeans and tomatoes. However, in bell peppers more fruit was estimated for control plots.

The weather (Table 20) especially the frequent rainfall and dew, probably affected the released larvae of C. carnea considerably during this experiment. Mortality was probably high due to the wet condition of the plants during this experiment and searching of individual larvae was probably reduced.

Additional Tests on Efficiency of C. carnea Shipped From College Station.--- In the first test more eggs were found missing in C. carnea release plots; however, differences were probably not significant (Table 21). Only three larvae of C. carnea were found in the release plots for an average of 0.8 C. carnea per 3 ft section of row.

In the second test in the 6 X 6 X 12 - ft cage larvae of C. carnea could not be found 24 hr after releases. However, during inspections of 24-ft of row, only 15 soybean looper eggs were found. Thus, there was probably little food available for the larvae of C. carnea.

In the third test 26% of the larvae of C. carnea were found 24 hr after caging on portions of plants in crops of the shade and growth of some was observed. (Table 22) Recovery at 24 hr was highest on bush beans (67%) and lowest on collards

and peppers (0%). Total larvae recovered after 48 and 72 hr in the field was only 10% and 3% of estimated number released initially.

In the fourth test in the laboratory, 5 to 6-day-old larvae of C. carnea fed on all hosts presented in the test (Table 23). An average of 7.2 eggs were consumed in 48 hr; and 3.3 larvae were consumed in 24 hr.

Table 15. Estimated numbers per acre of eggs and larvae of <u>Heliothis</u> spp. found on crops in one-acre tobacco shade following releases of <u>C. carnea</u> larvae.[a/] [b/]

Date (week of)	Bush beans				Tobacco				Soybeans			
	Eggs in plots		Larvae in plots		Eggs in plots		Larvae in plots		Eggs in plots		Larvae in plots	
	Release	Control	Release	Control	Release	Control	Release	Control	Release	Control	Release	Control
Aug. 1	0	-	0	-	44	-	260	-	0	-	0	-
8	450	-	0	-	0	-	0	-	70	-	40	-
15	0	0	0	70	580	780	0	0	800	410	70	70
22	0	440	150	150	580	440	70	1450	290	1020	290	0
29	0	580	0	0	340	4650	440	730	2810	290	100	0
Sept.5	0	70	220	880	110	2690	1340	1930	140	0	140	70
12	0	0	0	0	0	510	2400	1820	0	0	290	0
19	0	0	290	290	0	140	2040	1450	0	0	4360	4360
Avg.	0	220	130	260	210	1690	1260	1480	650	340	1040	890

(Con t).

Table 15. (Cont.)

Date (Week of)	Bell peppers				Tomatoes			
	Eggs in plots		Larvae in plots		Eggs in plots		Larvae in plots	
	Release	Control	Release	Control	Release	Control	Release	Control
Aug. 1	0	-	0	-	0	-	40	-
8	0	-	0	-	0	-	0	-
15	460	0	0	0	2210	1220	70	0
22	0	0	0	150	580	870	150	870
29	0	0	0	0	3300	3300	200	190
Sept.5	70	0	220	0	870	220	360	290
12	1310	0	0	0	6400	0	4070	3640
19	0	0	0	0	0	290	4650	870
Avg.	280	0	60	30	2230	940	1190	1170

a/C. carnea releases averaging 190,000 per acre were made on Aug. 20, 27, and Sept. 4 and 5.

b/An additional release of C. carnea estimated at 50,000 per acre was made in soybeans on Sept. 16.

Table 16. Estimated numbers per acre of looper eggs and larvae found on crops in one acre tobacco shade following releases of *C. carnea* larvae.[1/,2/]

Date (Week of)	Bush beans				Tobacco			
	Eggs in plots		Larvae in plots		Eggs in plots		Larvae in plots	
	Release	Control	Release	Control	Release	Control	Release	Control
Aug. 1	250	-	0	-	0	-	0	-
8	0	-	0	-	40	-	0	-
15	60	180	150	510	0	410	0	0
22	0	150	0	0	70	650	0	0
29	290	480	0	0	0	100	0	0
Sept. 5	0	220	290	940	0	0	150	70
12	0	0	290	1310	0	510	0	0
19	0	0	580	1160	0	140	0	0
Avg.	60	170	230	680	10	280	30	10

(Cont.)

Table 16. (Cont.)

Date (Week of)	Soybeans				Collards			
	Eggs in plots		Larvae in plots		Eggs in plots		Larvae in plots	
	Release	Control	Release	Control	Release	Control	Release	Control
Aug. 1	0	-	0	-	2070	-	1550	-
8	0	-	220	-	7450	-	0	-
15	1400	2150	140	1240	17510	344310	15560	36570
22	870	580	440	580	55540	52930	12210	20790
29	2620	2720	680	390	26270	29560	3530	7150
Sept.5	1090	440	2040	1450	56120	43330	23990	22460
12	290	0	3340	3930	28350	25880	66450	82590
19	0	290	0	0	9310	10180	15410	8430
Avg.	970	810	1300	1270	35120	32380	24320	28280

(Cont.)

Table I[illegible] (Cont.)

Date (Week of)	Cabbage				Bell peppers				Tomatoes			
	Eggs in plots		Larvae in plots		Eggs in plots		Larvae in plots		Eggs in plots		Larvae in plots	
	Release	Control	Release	Control	Release	Control	Release	Control	Release	Control	Release	Control
Aug. 1	160	-	860	-	92	-	0	-	0	-	0	-
8	5660	-	1680	-	0	-	0	-	80	-	0	-
15	19020	22680	9020	13740	2210	180	0	0	1740	990	70	360
22	21400	35480	9890	8000	2690	2180	290	580	440	3930	160	150
29	16580	13090	4750	4560	0	290	0	0	3300	580	0	0
Sept.5	15700	16790	11270	12900	290	0	0	70	0	0	70	0
12	14100	9310	31260	40420	2330	3200	290	0	580	0	440	290
19	1740	0	2040	0	0	5[illegible]0	580	0	0	0	0	0
							2					
Avg.	13900	1494[illegible]	11840	13190	1060	[illegible]	232	1[illegible]0	860	902	132	88

a/ C. carnea releases averaging 190,000 per acre were made on Aug. 20, 27, and Sept. 4 and 5.

b/ An additional release of C. carnea estimated at 50,000 per acre was made in soybeans and collards on Sept. 16.

Table 17. Average numbers per 10 ft of row of *Chrysopa* spp. larvae found in crops of one-acre tobacco shade following supplemental releases of this predator.

	Bush beans		Tobacco		Soybeans		Collards		Cabbage		Peppers		Tomatoes	
	Release	Control	Release	Control	Release	Control	Release	Control	Release	Control	Release	Control	Release	Control
Aug. 20[a/b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27[a/b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	15.5	-	14.0	-	8.5	-	2.5	-	7.5	-	4.5	-	7.5	-
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sept. 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0
4[a]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5[a]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	0.2	0.0	1.7	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.1	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug. 25	0.0	0.0	0.0	0.0	0.8	0.1	0.0	0.0	0.0	0.0	0.6	0.0	0.1	0.0
Sept. 1	0.1	0.0	0.4	0.0	0.7	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
9	0.5	0.0	0.2	0.0	1.2	0.0	0.3	0.0	0.7	0.0	0.4	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.6	0.1	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0

a/ *C. carnea* were released on these dates.

b/ Counts were made prior to releases on these dates.

Table 18. Rating of foliage damage for crops of one-acre tobacco shade following releases of _T. pretiosum_ and _C. carnea_.[a]

	8/24	9/2	9/11	9/23	Average
Bush beans					
C. carnea release plots	2.4	2.4	2.3	4.1	2.8
Control plots	2.1	1.9	1.8	3.6	2.4
Tobacco					
C. carnea release plots	2.7	3.0	2.8	3.8	3.1
Control plots	3.1	2.9	3.0	4.0	3.2
Soybeans					
C. carnea release plots	2.0	2.1	2.8	4.2	2.8
Control plots	2.1	2.2	2.8	4.3	2.8
Collards					
C. carnea release plots	3.9	4.3	4.2	5.9	4.6
Control plots	3.5	4.6	5.0	5.7	4.6
Cabbage					
C. carnea release plots	3.5	4.7	5.2	5.9	4.8
Control plots	4.3	4.6	5.6	5.9	5.2
Bell peppers					
C. carnea release plots	1.4	1.6	1.7	2.1	1.7
Control plots	1.4	1.8	1.7	2.2	1.7
Tomatoes					
C. carnea release plots	1.9	2.0	2.3	4.3	2.6
Control plots	2.0	2.0	2.4	3.9	2.6

[a] The rating system was used as a scale ranging from 1 to 6 as follows: 1) no apparent insect feeding, 2) 0 - 1% leaf area eaten, 3) 2 - 5% leaf area eaten, 4) 6 - 10% leaf area eaten, 5) 11 - 30% leaf area eaten, and 6) over 30% of the leaf area eaten.

Table 19.--Yields of fruit and percent damaged fruit on crops of one-acre tobacco shade following releases of *T. pretiosum* and *C. carnea*.

	1st Check		2nd Check		3rd Check		4th Check		Average	
	No. fruit/ acre	% damage	No. fruit/ acre	% damage	No. fruit/ acre	% damage	No. fruit/ acre	% damage	No. fruit/ acre	% damage
Bush Beans[a]										
C. carnea release plots	51840[f]	0.5[f]	191,940	2.4	--	--	--	--	191,940	2.4
Control plots			174,480	1.4					174,480	1.4
Soybeans[b]										
C. carnea release plots	2,673,910	0.0	--	--	--	--	--	--	2,673,910	0.0
Control plots	2,368,570	0.0							2,368,570	0.0
Bell peppers[c]										
C. carnea release plots	1.340	0.0	6,540	0.4	39,260	0.9	--	--	16,710	0.4
Control plots	1.640	0.0	9,450	1.3	39,260	0.0			16,780	0.4
Tomatoes[d]										
C. carnea release plots	7.270	0.0	22,540	6.8	31,990	19.3	39,260	13.8	25,260	10.0
Control plots	10,180	0.0	12,360	8.3	23,260	15.3	34,900	10.6	20,180	8.6
Ripe tomatoes[e]										
C. carnea release plots	300	16.4	570	45.2	--	--	--	--	440	30.8
Control plots	90	0.0	360	52.4					220	26.2

[a] Checked 9/8 and 28.
[b] Checked 10/4
[c] Checked 8/3, 9/16, and 10/8.
[d] Checked 9/3, 9/16, 9/22, and 10/8.
[e] Checked 9/17, and 9/22.
[f] Average from release and control plots.

Table 20--Weather conditions for August and September, 1971 at the North Florida Agricultural Research and Education Center, Quincy, Fla.[a]

Date	Amt. rainfall	Hi/Lo temp. (°F)	Min. % R.H.	Prevailing wind direction	Avg. wind velocity (mph)	Avg. % cloud Cover[b]
Aug. 4	0.16	93/68	51	V	1.91	50
5	0.12	92/70	58	V	1.58	60
6	0.22	89/70	57	E	2.78	50
7	0.0	90/70	60	E	2.08	60
8	0.0	93/70	57	SE	1.54	50
9	0.0	92/72	50	V	1.45	70
10	0.0	91/71	57	V	1.54	60
11	0.03	91/72	58	W	2.08	60
12	0.0	90/72	-	NW	-	70
13	0.0	90/70	60	E	2.50	30
14	0.0	89/70	52	NE	2.16	30
15	0.70	89/70	61	NE	2.75	90
16	0.11	89/73	61	NE	2.50	90
17	0.58	88/68	-	E	-	80
18	0.04	89/69	68	E	1.70	70
19	0.01	88/67	58	E	1.33	70
20	0.0	92/68	54	V	1.16	50
21	0.07	93/70	52	V	1.42	60
22	0.03	93/69	52	V	1.16	60
23	0.02	89/71	64	W	1.38	70
24	T	92/70	51	W	1.50	60
25	0.0	86/68	63	SE	1.58	90
26	0.24	84/69	72	SE	1.79	90
27	0.0	89/69	57	V	1.66	70
28	0.20	89/69	61	E	1.46	70
29	0.18	87/69	72	E	2.00	80
30	0.23	89/70	64	E	2.70	90
31	T	88/71	64	E	2.70	70
Sept. 1	T	90/70	62	SE	3.04	60
2	T	90/70	58	E	3.45	70
3	0.08	82/72	68	E	4.20	90
4	0.31	82/72	66	E	2.92	90
5	0.0	89/71	62	E	3.17	70
6	T	89/72	57	E	3.90	60
7	0.02	89/69	54	E	3.90	70
8	0.07	87/70	61	E	4.00	90
9	1.07	87/71	68	E	4.45	80
10	0.0	88/68	54	V	1.38	60
11	T	89/68	55	W	2.58	80
12	0.0	86/70	61	W	2.17	90

(Cont.)

Table 20 (Cont.)

Date	Amt. rainfall	Hi/Lo temp. (°F)	Min. % R.H.	Prevailing wind direction	Avg. wind velocity (mph)	Avg. % Cloud cover
Sept. 13	0.0	85/65	38	NW	2.54	40
14	0.0	89/56	37	W	1.66	10
15	0.0	86/60	53	V	0.58	90
16	0.0	86/62	65	SE	1.45	90
17	0.27	87/69	62	S	2.54	80
18	0.0	89/66	56	NW	1.58	70
19	0.0	91/64	49	V	1.08	30
20	0.02	92/66	47	V	0.66	50
21	0.0	91/66	56	E	1.37	40
22	0.0	89/67	57	E	2.50	40

a/ Obtained from National Weather Service Records, Quincy, Florida.

b/ This was calculated from data collected in Tallahassee, Florida.

Table 21. Soybean looper egg consumption by 4-day-old _C. carnea_ sent from College Station and released in soybeans.[a]

Treatment	No. eggs initially	Avg. no. eggs missing after 24 hr.[b]	Avg. no. _C. carnea_ found/sample after 24 hr.
C. carnea release rows	50	26 a	0.8
Control rows	50	22 a	0.0

[a] _C. carnea_ larvae were released in the soybean field at rates of about 238 per 3-ft section of row and replicated 4 times.

[b] Numbers were not significantly different according to the student's t test at a 1% level.

Table 22. Numbers of C. carnea larvae recovered from crops of one-acre tobacco shade 24-72 hr after being placed on plants individually in the presence of cabbage looper eggs.[a/][b/]

Crop	No. C. carnea initially	No. found 24 hr	No. found 48 hr	No. found 72 hr	No. of insects that grew after 24 hr in field
Bush beans	18	12	4	1	2
Tobacco	18	5	0	0	0
Soybeans	18	7	3	1	6
Collards	18	0	1	0	-
Cabbage	18	1	0	0	0
Peppers	18	0	1	2	-
Tomatoes	18	7	4	0	2
Avg.	18	4.6	1.8	0.6	1.4

[a/] Six C. carnea were caged on the plants initially in one gallon ice cream cartons and replicated 3 times. After 24 hrs. the cartons were removed, but C. carnea were left on the plants.

[b/] Fifty to 200 cabbage looper eggs were cemented on leaves of the plants near positions where C. carnea were placed.

Table 23. Consumption of tobacco budworm and cabbage looper eggs and larvae and soybean looper eggs by 5- to 6-day-old C. carnea larvae shipped from College Station. [a]

Host	No. C. carnea tested	No. offered	Avg. no. consumed	% mortality[b]
		Eggs (checked after 48hr)		
Tobacco budworm	15	20	6.5	26.7
Cabbage looper	15	20	6.3	20.0
Soybean looper	5	67-109	9.0	0.0
Avg.			7.2	15.6
		1st-instar larvae (checked after 24 hr)		
Tobacco budworm	10	10	3.6	10.0
Cabbage looper	10	15	3.9	20.0
Avg.			3.8	15.0

[a] C. carnea were held in small glass vials or plastic cups in the laboratory at 27±2° and a minimum relative humidity of about 50%.

[b] Percent mortality of C. carnea larvae

PREDATORS AND PARASITES OF *HELIOTHIS* SPP. AND LOOPER, AND MAJOR PESTS (OTHER THAN *HELIOTHIS* SPP. AND LOOPERS) FOUND ON CROPS IN TOBACCO SHADE TEST

The effectiveness of supplemental releases of Trichogramma spp. and Chrysopa spp. could depend on aid from native predators, parasites, and other potential mortality factors that might be present in an agro-ecosystem . Also, pests other than the target pests might confound control techniques for the target species by directly injuring a crop at an economic level or by interfering as alternate hosts of the released beneficials (either determentally or beneficially). Thus, number of predators, amount of parasitism and disease of larvae of Heliothis spp. and loopers and number of other major pests in each crop of the tobacco shade that could be important to an overall suppression program are presented in this section.

PROCEDURES.--Beneficial arthropods were sampled by vacuuming 200-ft sections of row per crop in the tobacco shade with a D-vac machine having a 1/3ft^2 sampling head. This was the same sampling technique described in the section on experiments with C. carnea (Chapter III, page -.) of Chapter III. Data obtained was converted to a per acre estimate by multiplying by a factor of 72.7.

Parasitism of larvae of Heliothis spp. and loopers was monitored by observations of larvae collected during whole plant inspections. The larvae were brought into the laboratory in ½-oz plastic jelly cups containing an artificial tobacco diet and allowed to develop at about 27°C. Larvae were visually examined weekly and parasites collected were preserved for future identification. Parasites were sent to the Division of Plant Industry, Gainesville, Fla., for identification, Dr. E. E. Grizzell, DPI, Gainesville, identified the Copidosoma sp. recovered from collected larvae, but the Apanteles spp. have been sent to P. M. Marsh, Systematic Entomology Laboratory, Entomol. Res. Div., ARS, USDA.

Number of pests per acre were estimated from whole plant inspections and in D-Vac sampled as described previously. Grasshopper numbers were counted while walking down three 200-ft rows of each crop on September 13 and 22. Per acre estimates of grasshoppers were made by multiplying numbers found per crop by 24.

NUMBERS OF PREDACEOUS ARTHROPODS FOUND.--Estimates from counts in D-vac samples, indicate numbers of predators in crops of the tobacco shade were generally low (Table 24). Numbers in tobacco were the lowest (avg. of 920 per acre) while numbers in bell peppers reached the highest levels (69, 850 per acre.

Ants and spiders were common in all crops and were the major groups in tobacco, soybeans, collards, cabbage, and tomatoes. Specimens of the ants and spiders have not been identified; however, most of the ants were fire ants, Solenopsis spp. (W. Morrill, Univ. of Fla., Quincy, Fla., personnel communication).

Excluding ants, the most common insect predator groups collected with the D-vac samples were Nabis spp. in bush beans, Geocoris spp. in tobacco and tomatoes, Nabis spp. and Notoxus spp. in soybeans. In bell peppers Notoxus spp. were estimated to reach levels of 64,700 per acre; thus, it reached the highest numbers of any of the predators observed.

PARASITISM AND DISEASE OF LARVAE OF HELIOTHIS SPP. AND LOOPERS.--Levels of parasitism of larvae of Heliothis spp. were low in all crops of the tobacco shade (Table 25). Cardiocles nigriceps Viereck was the only parasite found on Heliothis spp. on tobacco, one crop in which parasitism of larvae of Heliothis spp. was found frequently. (All larvae identified were tobacco budworms). Parasites recovered from larvae of Heliothis spp. on tomatoes and cabbage were tentatively identified as Apanteles marginiventris (Cresson). No parasites were found from larvae of Heliothis spp. on bush beans, soybeans, collards, or peppers; however, very few larvae were collected on these crops.

Results from monitors on parasitism of looper larvae indicate that level of parasitism was quite high in bush beans, soybeans, peppers and tomatoes and low in collards and cabbage (Table 26). The average parasitism of looper larvae on the non-crucifers was 50% while it averaged only 5% in collards and cabbage. Parasites recovered from looper larvae were

identified as Copidosoma truncatellum (Dalman) and tentatively identified as A. marginiventris and A. glomeratus (L.).

Disease probably due to a nuclear polyhedrosis virus, began to be prevalent in collards and cabbage beginning the week of September 5 (Table 26). Results indicate it was mortally affecting 43% of the looper larvae in collards when this experiment was terminated. Results indicate few larvae of Heliothis spp. were affected mortally by disease organisms.

DENSITIES OF PESTS OTHER THAN HELIOTHIS SPP. OR LOOPERS.--Numbers estimated per acre of the two most numerous pests on each crop other than Heliothis spp. or loopers are presented in Table 27.

High density levels of eggs and larvae of the imported cabbageworm may have affected the searching and feeding or stinging efficiency of eggs of Heliothis spp. or loopers by Trichogramma spp. and Chrysopa spp., but no other host which might have had this effect was apparent. Aphids (a host of Chrysopa spp.) were not monitored to estimate numbers, but observations made during the test indicated numbers were low or nil, probably because of hot weather and frequent thundershowers.

Probably no economic damage was done to bush beans except perhaps by Mexican bean beetles, Epilachna varivestis Mulsant. Hornworms fed on a few tobacco leaves, but major damage in tobacco was probably done by tobacco flea beetles, Epitrix hirtipennis (Melsheimer) and tobacco suckflies, Crytopeltis notatus Distant. In collards and cabbage, economic levels of damage was produced by grasshoppers and the imported cabbageworm. Although the corn earworm (=tomato fruitworm) was probably most destructive in tomatoes, hornworms stripped a number of plants of their foliage and probably caused economic damage. Probably no single pest species in soybeans or bell peppers caused economic damage.

Whiteflies were numerous in all crops throughout the test. Larvae of the diamond-back moth, Plutella maculopennis (Curtis), green cloverworms, Plathypena scabra (Fabricius), Prodenia spp., and Agrotis spp. were found infrequently in various crops of the shade.

able 24.--Estimated numbers per acre of selected arthropod predators in crops of the tobacco shade.

ate Week of)	1	2	3	4	5	6	7	8	9	10	Total
					Bush beans						
ug 15	250	40	260	0	70	0	290	110	110	250	1380
22	70	0	140	290	290	0	360	440	360	2110	4060
29	290	0	730	220	580	70	70	580	290	4580	7410
ept 5	220	0	220	1160	770	0	1310	510	1380	2400	7970
12	440	0	360	650	510	0	290	360	1160	3050	6820
19	360	0	870	2040	360	0	220	140	1890	2640	8520
vg.	270	10	430	730	430	10	420	360	860	2500	6030
					Tobacco						
ug 15	0	0	0	0	40	0	70	0	0	140	250
22	0	0	0	0	0	0	0	70	70	140	280
29	0	0	70	0	70	0	0	0	70	870	1080
ept 5	0	0	0	0	70	0	0	870	70	140	1150
12	0	0	0	70	290	0	220	410	0	360	1380
19	0	0	70	0	220	0	0	290	220	580	1380
vg.	0	0	20	10	120	0	50	280	70	370	920
					Soybeans						
ug 15	0	0	0	40	250	0	870	1820	0	1120	4110
22	0	0	70	70	140	0	360	360	140	1380	2520
29	220	0	0	0	140	70	70	1020	70	800	2320
ept 5	70	0	0	580	0	0	870	940	510	2250	5220
12	70	0	510	1160	800	0	770	800	660	1450	6220
19	140	0	290	1310	360	0	220	220	730	1670	4940
vg.	80	0	140	530	280	10	530	860	350	1450	4220
					Collards						
ug 15	0	0	0	70	70	0	140	730	0	180	1190
22	0	0	0	0	0	0	290	360	220	360	1230
29	0	0	140	0	0	0	290	2470	0	1090	3990
ept 5	70	0	440	70	70	70	1090	3420	440	650	6320
12	140	0	290	70	70	0	940	770	220	1670	4170
19	70	0	70	140	70	140	800	1240	440	2180	5150
vg.	50	0	160	60	50	40	540	1500	220	1020	3680

(Continued)

ble 24 (Continued)

te Week of)	1	2	3	4	5	6	7	8	9	10	Total
						Cabbage					
g 15	0	0	110	0	0	0	220	4830	0	910	6070
22	0	0	0	70	0	0	140	0	0	510	720
29	0	0	0	0	0	0	140	3110	140	290	3680
pt 5	0	0	0	0	0	440	510	0	0	440	1390
12	0	0	0	140	0	0	440	1310	0	220	2110
19	0	0	0	0	0	0	360	580	0	220	1160
vg.	0	0	20	40	0	70	300	1640	20	430	2520
						Bell peppers					
g 15	0	0	0	0	0	0	220	4250	40	0	4580
22	70	70	580	70	220	0	2040	220	140	580	3990
29	0	0	140	0	0	0	650	1450	0	650	2890
pt 5	650	0	1020	70	0	70	8800	2980	140	2760	16490
12	360	0	440	140	0	0	4580	220	220	1670	7630
19	360	140	870	0	290	510	64700	510	140	2330	69850
vg.	240	40	510	50	90	100	13500	1600	110	1340	17570
						Tomatoes					
g 15	0	0	40	0	0	0	0	40	40	1000	1120
22	0	0	140	220	0	0	0	140	0	650	1150
[illegible]	0	0	440	70	140	0	150	220	70	1380	2470
pt 5	0	0	140	70	360	0	290	3180	220	1600	5860
12	70	0	290	0	140	70	360	290	510	1960	3690
19	140	70	360	2980	3200	2910	1960	510	3640	2330	18100
vg.	[illegible]	10	240	560	640	500	460	730	750	1490	5400

The numbered columns represent the following predators: 1) adults and immatures of Coleomegilla spp., 2) adults of Cycloneda spp., 3) adults of Scymnus spp., 4) Nabis spp., 5) Geocoris spp., 6) Orius spp., 7) adults of Notoxus spp., 8) Formicids; 9) other predaceous insects including adults of Podisus sp., Anthocorids other than Orius spp., Dermaptera Carabids, and adults and immatures of Hemerobiids and Reduviids;&(10) immatures and adults of Araneae.

Table 2[illegible].--Parasitized and diseased larvae of *Heliothis* spp. on crops of one-acre tobacco shade.[a/]

Week of	Bush beans			Tobacco			Soybeans			Collards		
	No. larvae collected	% parasitized	% diseased	No. larvae collected	% parasitized	% diseased	No. larvae collected	% parasitized	% diseased	No. larvae collected	% parasitized	% diseased
Aug 15	0	-	-	0	-	-	1	0	0	0	-	-
22	0	-	-	14	0	0	2	0	0	0	-	-
29	0	-	-	11	9	0	1	0	0	0	-	-
Sept 5	7	0	0	83	7	1	0	-	-	1	0	0
12	0	-	-	20	35	0	0	-	-	0	-	-
19	0	-	-	19	5	5	0	-	-	0	-	-
Avg.	1.2	0	0	24.5	11	1	0.7	0	0	0.2	0	0

(Continued)

Table 25. Continued.

Week of	Cabbage			Bell peppers			Tomatoes		
	No. larvae collected	% parasitized	% diseased	No. larvae collected	% parasitized	% diseased	No. larvae collected	% parasitized	% diseased
Aug. 15	0	-	-	0	-	-	1	100	0
22	0	-	-	1	-	-	1	0	0
29	0	-	-	3	-	-	3	33	0
Sept. 5	1	100	0	0	-	-	3	0	0
12	0	-	-	0	-	-	14	6	0
19	0	-	-	0	-	-	33	0	5
Avg.	0.2	100	0	0.7	-	-	10.3	23	1

a/ Most disease was probably due to a polyhedrosis virus.

b/ All parasites were identified as C. nigriceps.

c/ All parasites were tentatively identified as A. marginiventris.

Table 26.--Parasitized and diseased looper larvae on crops of one-acre tobacco shade.[a]

Week of	Bush beans			Tobacco			Soybeans			Collards		
	No. larvae collected	% parasitized[b]	% diseased	No. larvae collected	% parasitized	% diseased	No. larvae collected	% parasitized	% diseased	No. larvae collected	% parasitized	% diseased
Aug. 15	2	50	0	0	-	-	10	50[c]	0	49	0	0
22	0	-	-	0	-	-	6	67[d]	0	93	7[e]	0
29	1	0	0	0	-	-	6	50[b]	0	20	5[b]	0
Sept. 5	5	60	30	13	0	54	20	40[e]	0	235	5[c]	11
12	2	50	0	0	-	-	2	0	0	38	0	16
19	0	-	-	0	-	-	0	-	-	14	7[f]	43
Avg.	1.7	40	3	2.2	0	54	7.3	34	0	68.5	4	12

(Continued)

Table 26.--Continued.

Week of	Cabbage			Bell peppers			Tomatoes		
	No. larvae collected	% parasitized	% diseased	No. larvae collected	% parasitized	% diseased	No. larvae collected	% parasitized	% diseased
Aug. 15	51	0	0	0	-	-	2	50	0
22	53	8[c/]	0	2	100[d/]	0	1	-	-
29	22	0	9	0	-	-	0	-	-
Sept. 5	108	5[e/]	14	0	-	-	1	100	0
12	0	-	-	0	-	-	0	-	-
19	0	-	-	0	-	-	0	-	-
Avg.	39.0	3	5	0.3	100	0	0.7	75	0

a/ Most disease was probably due to polyhedrosis virus.

b/ All parasites were C. truncatellum.

c/ Parasites were tentatively identified as A. marginventris and A. glomeratus.

d/ Parasites were identified as C. truncatellum or tentatively identified as A. glomeratus.

e/ Parasites were identified as C. truncatellum or tentatively identified as A. marginventris and A. glomeratus.

f/ Parasites were tentatively identified as A. glomeratus.

Table 27.--Estimated numbers per acre of the major pests found in crops of one-acre tobacco shade.[a]

	Averages for week of							
	8/1	8/8	8/15	8/22	8/29	9/5	9/12	9/19
Bush beans								
Mexican bean beetles[b]	500	0	1260	6690	290	2690	6960	22790
Grasshoppers[c]	0	0	140	-	-	-	240	1150
Tobacco								
Flea beetles[c]	6070	2830	3780	6980	9090	4220	2540	7920
Tobacco suckflies[c]	-	-	180	3130	6620	10610	62230	59540
Soybeans								
Velvetbean caterpillars[d]	0	0	0	0	0	1160	440	13230
Mexican bean beetles[b]	0	0	0	1450	290	2620	440	1450
Collards								
Imported cabbageworm[d]	2840	4360	16210	22030	2230	24460	39690	10610
Grasshoppers[c]	0	0	-	-	-	-	840	1580
Cabbage								
Imported cabbageworm[d]	730	1120	7600	11010	1410	3900	22540	1450
Grasshoppers[c]	0	0	140	-	-	-	150	1270
Peppers								
Flea beetles[c]	4600	4140	1020	8000	2110	2330	290	0
Grasshoppers[c]	0	0	0	-	-	-	700	1010
Tomatoes								
Hornworms[d]	0	0	0	0	0	140	650	291
Flea beetles[c]	4800	3130	17230	12360	5120	6300	870	870

a/ Numbers were estimated from whole plant inspection sampling except for suckflies in tobacco, which were estimated from D-vac samples.

b/ Adults and larvae.

c/ Adults.

d/ Larvae.

IV. SUMMARY OF RESULTS AND CONCLUSIONS

HOST PLANT PREFERENCES.--Tobacco budworms preferred tobacco over other hosts in the tobacco shade test. Ninty-eight percent of the tobacco budworm larvae collected and identified from the seven crops were from tobacco. (Table 3). Numbers of total eggs and larvae of Heliothis spp. per 10-ft of row were substantially higher in tobacco and tomatoes than in any other crops, but numbers in the two crops were similar. Most of the larvae of Heliothis spp. were identified as corn earworms in crops other than tobacco.

In the small cage test more eggs of the tobacco budworm were oviposited on tomatoes (84%) than on tobacco (11%)(Table 5); however, tomato plants possessed more foliage than other hosts in this test. No data w-- collected on the tobacco budworm larvae in the small cage test (eg. survival on tomatoes).

Cabbage loopers preferred collards and cabbage to other crops in both the tobacco shade test and the small cage (Tables 6, 7, and 8). Collards received more cabbage looper eggs than other hosts in both tests (62% and 40% compared with 31% and 30% for cabbage) (Tables 7 and 8).

Soybean loopers preferred soybeans over the other 6 hosts in the tobacco shade test, with 65% of the soybean looper larvae being found on soybeans (Table 6). However in the small cage test, most eggs were found on cockleburs, tomatoes, and soybeans, respectively.

Results from host plant preference studies of the tobacco budworm, cabbage looper, and soybean looper indicate that perhaps collards could be planted as a trap crop for cabbage loopers and that tobacco might be used as a trap crop for the tobacco budworm. However in a recent study, (Martin et al. 1973), despite a larger acreage of tobacco adjacent to a

25.--Tobacco budworms preferred tobacco over

[illegible] hosts in the tobacco shade test. Ninety-eight percent of the tobacco [illegible]

[illegible] larvae [illegible] and identified from [illegible] seven [illegible] were [illegible]

(Table 3). Numbers of total eggs and larvae [illegible] Heliothis [illegible]

10-ft of row were substantially higher in tobacco and tomatoes than

other crops, but numbers in the two crops were [illegible] lost of

larvae of *Heliothis* spp. were identified [illegible] crops

[illegible] than tobacco.

In the small cage test [illegible] eggs of the tobacco budworm were depo-

[illegible] on tomatoes (84%) than on tobacco [illegible] (Table 5); however [illegible]

[illegible] plants possessed more foliage than other hosts [illegible] this test. [illegible]

collected on the tobacco budworm larvae in the small cage [illegible]

[illegible] on tomatoes).

Cabbage loopers preferred collards and cabbage [illegible] other crops in the

tobacco shade test and the small cage (Tables 6, 7, and 8). Collards

received more cabbage looper eggs than other hosts in [illegible] tests (61% and

[illegible] compared with 31% and 30% for cabbage) (Tables [illegible] and [illegible]).

Soybean loopers preferred soybeans over the other [illegible] hosts in the

tobacco shade test, with 65% of the soybean looper larvae being [illegible]

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[illegible] for the tobacco budworm. However in a recent study,

[illegible] 973), despite a large acreage of tobacco adjacent to a

crop of tomatoes, numbers of tobacco budworms in tomatoes rose to above economic levels. In this recent study, involving year-round sampling of crops and weeds on and surrounding an 8-acre farm (including crops used in this report), results indicate that the tobacco budworm prefers tobacco, but it may also be found in high numbers on tomatoes, okra, and prickly sida, Sida spinsoa L. In the same study cabbage loopers have been found almost exclusively on collards and cabbage, and soybean loopers on soybeans.

SUPPLEMENTAL RELEASES OF T. PRETIOSUM.--In tests on T. pretiosum, percent parasitism of eggs of Heliothis spp. in tomatoes and soybeans averaged about 68 and 67%. Results from whole plant inspections also indicate potential larval numbers were suppressed. Tobacco was the only other crop possessing sufficient numbers of Heliothis spp. to check for suppression by T. pretiosum and results of moniters on egg parasitism and counts of eggs and larvae indicate practically no suppression occurred.

Monitors on parasitism of looper eggs indicate reduction of hatch by T. pretiosum was high in tomatoes (avg. 72%) and moderate in collards, cabbage, soybeans, and peppers (avg. 21-39%) (Table 11). Results from whole plant inspections also indicated potential hatch was reduced. In tobacco, numbers of loopers were not sufficient to moniter parasitism.

Results on both Heliothis spp. and loopers show parasitism increased dramatically following releases of T. pretiosum (Table 10 and 12). Parasitism decreased in all crops except tomatoes, after releases were terminated.

The marked increase in egg parasitism following releases of T. pretiosum in the tobacco shade test indicate most parasitism was due to the initial release of T. pretiosum. Specimens of Trichogramma spp. collected in this

test are being identified by Lawrence Ertle (Introduced Beneficial Insects Research Laboratory, ARS, USDA, Moorestown, New Jersey) in hopes of determining more precisely the amount of egg parasitism due to native parasites. Tentative identifications indicate the released species of Trichogramma was the only species recovered from cabbage looper eggs, however several species (including the released species of Trichogramma) have been recovered from Heliothis spp,,

The potential for suppression by the released T. pretiosum may not have been reached for several reasons. Frequent rainfalls, the heavy dew present regularly from about 10 p.m. - 11 a.m., and other weather factors (Table 20) may have hindered the parasites. Also, earlier releases on loopers would probably have increased suppression of the cabbage loopers on collards and cabbage (Table 11). This may have eliminated the need for the early application of mevinphos (Table 1); thus effectiveness of native parasites and predators may have also been increased (Tables 23, 24, and 25).

Results indicate alternate hosts did not interfere with parasitism by T. pretiosum (Table 14). However, some pests of the crops other than loopers or Heliothis spp. caused considerable damage and in a normal farming operation some types of additional control would have been necessary for imported cabbageworms in collards and cabbage, and flea beetles in tobacco.

Despite these factors which may have reduced the effectiveness of supplementary releases by T. pretiosum, this biological control technique does appear to have considerable potential for control of loopers on collards and cabbage and Heliothis spp. and loopers on tomatoes and soybeans. Only in tobacco do results indicate T. pretiosum

could not be used. (Recent data of natural parasitism of lepidopterous eggs in tobacco supports this (Martin et al., 1973).)

In further analysis of the data, results indicate there was very little difference in parasitism by T. pretiosum between the eggs of Heliothis spp. and eggs of loopers on the crops tested. In tomatoes, average parasitism of 167 eggs of Heliothis spp. and 77 looper eggs was 64% and 65%, respectively. (Tables 10 and 12). Most of these eggs were found on the lower surfaces of the leaves. Data collected was not sufficient to determine specifically differences in parasitism of eggs of the tobacco budworm, corn earworm, the cabbage looper, and the soybean looper. Results indicate eggs of the hornworm and the velvet bean caterpillar may be suitable hosts of this strain of Trichogramma, but that the imported cabbageworm was not (Table 14).

The relationship between egg densities and percent parasitism by T. pretiosum was not clear from the results of this test. However it seems that when the host habitat was suitable, parasitism was high despite low host densities. Parasitism of approximately equal densities of eggs of Heliothis spp. was high in tomatoes and low or non-existent in tobacco. Parasitism of looper eggs was highest in tomatoes even though host densities were similar in soybeans and peppers and much greater in collards and cabbage.

SUPPLEMENTAL RELEASES OF C. CARNEA.--There is some evidence that C. carnea may have reduced numbers of eggs and larvae of Heliothis spp. in bush beans and tobacco and eggs and/or larvae of loopers in bush beans, tobacco, collards, cabbage, bell peppers, and tomatoes (Tables 15 and 16). However, differences in numbers in C. carnea release and

control plots are mostly slight and probably not significant. Differences in egg numbers of Heliothis spp. in bush beans, and tobacco, and of loopers in bush beans and cabbage probably accounted for differences in larval numbers. And differences in egg numbers may be explained by several factors, e.g. tobacco plants in the release plots were somewhat larger and had more foliage than those in the control plots.

The low recovery of released C. carnea in whole plant inspection and D-vac samples (less than 10%) indicate few C. carnea survived following releases. However Kinzer et al. (1971) showed that despite significant control of Heliothis spp. in cotton by larvae of C. carnea at release rates of 30,000 - 100,000 per acre, a maximum of only about 8% of the larvae were recovered from estimates in whole plant inspections. In the tobacco shade test, C. carnea should have been substantially easier to find in tobacco, collards, and bell peppers and probably more difficult to find in soybeans and tomatoes, than in the 2 to 5-ft cotton used in studies by Kinzer et al. (1971).

Results from foliage damage ratings and percent fruit damage estimates in crops of the tobacco shade indicate no difference in C. carnea release plots and control plots. This suggests no control of loopers or Heliothis spp. by released C. carnea.

In additional tests on the C. carnea received from College Station, recovery from the field was low. However, results from two tests (Tables 21 and 22) indicate the predators would feed on eggs and larvae of Heliothis spp. and loopers following shipments from College Station.

C. carnea have apparently been not known to occur in Florida (W. H. Whitcomb, Dept. of Entomol. and Nematol., Gainesville, Fla.

32611, Gainesville, Florida, personal communication).[3/] The regular rainfall and prevalent moisture on the plants (Table 20) may have reduced effectiveness of the released larvae of C. carnea for preying on eggs and larvae in the field.

Most results from tests with C. carnea were not conclusive. However, as methods of mass-producing and releasing this and other species of Chrysopa are researched and developed further, supplementary releases may produce desirable results in certain crops of southeastern United States.

[3/] One Chrysopa carnea adult was found in rye during April, 1973 at Hillside Farms, Quincy, Florida. (over 1½ years and ca. 3 miles from the nearest release point in this test). (Martin et al. unpublished data).

APPENDIX

Many of the patterns of behavior of the pests (Heliothis spp. and plusiinae) and beneficials (Trichogramma spp. and Chrysopa spp.) found in the study presented in this report have also been recorded during recent work in an eight-acre cropping system near Quincy, in which natural populations of these and other insects have been studied in the absence of applied control (Martin et al., 1973). For example, the soybean looper has been found in substantial numbers on tomatoes and the tobacco budworm has been found primarily on tobacco. Egg parasitism by Trichogramma spp. (estimated from weekly collections), has been less than 1% in tobacco, but often higher than 50% in tomatoes. The studies currently being conducted in the eight-acre cropping system should provide additional information as to when and how suppression techniques such as those tested in this repott might be used more effectively.

[illegible]

Many of the patterns of behavior of the pests ([illegible] plusia [illegible]) and beneficials (*Trichogramma* spp. and Chrysopa spp.) found in the study presented in this report have also been found during recent work in an eight-acre [illegible] which natural populations [illegible] in the absence of application [illegible] 1977). [illegible] the soybean looper has [illegible] and the tobacco budworm has [illegible] parasitism by *Trichogramma* [illegible] collections). has been less than 1% in tobacco, but [illegible] The studies currently being conducted [illegible] system should provide additional information [illegible] techniques such [illegible] this report might [illegible]

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